

**Amendments to the Specification:****Paragraph beginning on page 1, line 7**

*A<sup>1</sup>*  
The present invention relates generally to data communication systems and more particularly relates to an apparatus for and a method of controlling access to a communications media.

**Paragraph beginning on page 1, line 9**

*A<sup>2</sup>*  
Carrier Sense Multiple Access (CSMA) is a well-known media access mechanism, which is used for example in Ethernet LANs (IEEE Standard 802.3) and wireless LANs (IEEE Standard 802.11). They These network technologies are commonly used in networks that comprise shared media whereby multiple nodes simultaneously have access to the same media. The media may be any physical medium that can be simultaneously shared by many nodes, such as a cable, RF, powerline, etc.

**Paragraph beginning on page 1, line 26**

*A<sup>3</sup>*  
In many cases, a home, enterprise or other premise includes more than one communication network. Each communication network may be made up of a plurality of nodes with each network comprising at least two nodes. All nodes of the same network implement the same communication technique and are able to communicate communicate with each other thus permitting interoperability (assuming that the propagation conditions over the media enable communication). Nodes from different networks may implement different communications techniques, in which case they are not able to communicate with each other. In addition, the propagation characteristics of the shared media (e.g., the powerline grid) may have large variations and irregularities. This results in large variations in the attenuation over the communication path between two given nodes.

**Paragraph beginning on page 2, line 14**

*A<sup>4</sup>*  
Thus, it is desirable to have nodes that belong to different networks but share a common media be able to coexist with each other. Coexistence, i.e. media sharing, entails nodes from one network recognizing when that desire to communicate with nodes from another network desire to communicate and refraining from initiating new transmissions until the ongoing transmission is complete. However, nodes Nodes from different networks, however, typically utilize different communication protocol stacks, thus preventing them from detecting and understanding each other's messages (typically within the Physical layer).

*Paragraph beginning on page 3, line 11*

*A 5*  
Although this technique improves the reliability over the physical carrier sense mechanism, it still has the disadvantage disadvantages of (1) not permitting the coexistence of nodes incorporating difference different technologies and also suffers (2) suffering from the hidden node problem.

*Paragraph beginning on page 3, line 18*

*A 6*  
Referring to Figures 1B, 1C and 1D, the propagation conditions over the shared media are assumed to be such that adjacent nodes, e.g., nodes A and B, B and C, C and D, D and E, are able to hear one another. Non adjacent nodes, e.g., nodes A and C, are unable to hear each other. Further, assume that the media attenuation characteristics are such that simultaneous transmissions from two neighboring nodes interfere with each other. For example, simultaneous transmissions from nodes A and C interfere at node B such that node B is not aware of the transmissions. Note that the terms 'adjacent' and 'neighboring', as used in the descriptions of Figures 1B, 1C and 1D, refer solely to the alphabetic order of the letters indicating the nodes (i.e. A, B, C, D and E) and to the location of the nodes depicted therein. It does not necessarily have imply any relationship with the physical location of the actual nodes.

*Paragraph beginning on page 5, line 2*

*A 7*  
The present invention is a media access control (MAC) mechanism that utilizes synchronization signaling to enable nodes from different networks having different technologies and protocols to coexist using the same shared media. The present invention is suitable for use with a wide range of different types of network and technologies and is particularly useful in providing coexistence capabilities to powerline based data communication systems and wireless LAN systems. Wireless and powerline media, and especially the powerline media is are typically characterized by a large variety of propagation paths and conditions with the resultant resulting in the increased likelihood of hidden node and mask node situations problems.

*Paragraph beginning on page 5, line 24*

*A 8*  
In order to provide common timing for the frame occupation signal, a distributed synchronization mechanism is implemented. In accordance with the mechanism, each node is adapted to transmit on a random basis, a synchronization signal during a preassigned time slot during the frame. During times that a node does not transmit the synchronization signal, it listens to the media. A timing reference signal is derived from the synchronization signals received from other nodes during these quiet these listening periods. The node then adjusts its internal clock in accordance with the derived timing reference signal.

*11*  
*Paragraph beginning on page 10, line 6*

The present invention is a media access control (MAC) mechanism that enables nodes from different networks having different technologies and protocols to coexistence using the same shared media. The present invention is suitable for use with a wide range of different types of network and technologies and is particularly useful in providing coexistence capabilities to powerline based data communication systems and wireless LAN systems. ~~Wireless and powerline media, especially the powerline media is are~~ typically characterized by a large variety of propagation paths and conditions with the resultant ~~resulting in the increased likelihood of hidden node and mask node situations problems.~~

*10*  
*11*  
*Paragraph beginning on page 11, line 3*

In order to provide common timing for the frame occupation signal, a distributed synchronization mechanism is implemented. In accordance with the mechanism, each node is adapted to transmit on a random basis, a synchronization signal during a preassigned time slot during the frame. During times that a node does not transmit the synchronization signal, it listens to the media. A timing reference signal is derived from the synchronization signals received from other nodes during ~~those quiet these listening~~ periods. The node then adjusts its internal clock in accordance with the derived timing reference signal.

*11*  
*12*  
*13*  
*Paragraph beginning on page 11, line 28*

All nodes attached to the media are synchronized to each other using the synchronization method of the present invention presented hereinbelow. Thus, the frame timing for all nodes is identical at all frames. The accuracy of the frame timing, however, is limited only up to by the accuracy of the synchronization method.

*14*  
*15*  
*16*  
*17*  
*18*  
*19*  
*20*  
*21*  
*22*  
*23*  
*24*  
*25*  
*26*  
*27*  
*28*  
*29*  
*30*  
*31*  
*32*  
*33*  
*34*  
*35*  
*36*  
*37*  
*38*  
*39*  
*40*  
*41*  
*42*  
*43*  
*44*  
*45*  
*46*  
*47*  
*48*  
*49*  
*50*  
*51*  
*52*  
*53*  
*54*  
*55*  
*56*  
*57*  
*58*  
*59*  
*60*  
*61*  
*62*  
*63*  
*64*  
*65*  
*66*  
*67*  
*68*  
*69*  
*70*  
*71*  
*72*  
*73*  
*74*  
*75*  
*76*  
*77*  
*78*  
*79*  
*80*  
*81*  
*82*  
*83*  
*84*  
*85*  
*86*  
*87*  
*88*  
*89*  
*90*  
*91*  
*92*  
*93*  
*94*  
*95*  
*96*  
*97*  
*98*  
*99*  
*100*  
*101*  
*102*  
*103*  
*104*  
*105*  
*106*  
*107*  
*108*  
*109*  
*110*  
*111*  
*112*  
*113*  
*114*  
*115*  
*116*  
*117*  
*118*  
*119*  
*120*  
*121*  
*122*  
*123*  
*124*  
*125*  
*126*  
*127*  
*128*  
*129*  
*130*  
*131*  
*132*  
*133*  
*134*  
*135*  
*136*  
*137*  
*138*  
*139*  
*140*  
*141*  
*142*  
*143*  
*144*  
*145*  
*146*  
*147*  
*148*  
*149*  
*150*  
*151*  
*152*  
*153*  
*154*  
*155*  
*156*  
*157*  
*158*  
*159*  
*160*  
*161*  
*162*  
*163*  
*164*  
*165*  
*166*  
*167*  
*168*  
*169*  
*170*  
*171*  
*172*  
*173*  
*174*  
*175*  
*176*  
*177*  
*178*  
*179*  
*180*  
*181*  
*182*  
*183*  
*184*  
*185*  
*186*  
*187*  
*188*  
*189*  
*190*  
*191*  
*192*  
*193*  
*194*  
*195*  
*196*  
*197*  
*198*  
*199*  
*200*  
*201*  
*202*  
*203*  
*204*  
*205*  
*206*  
*207*  
*208*  
*209*  
*210*  
*211*  
*212*  
*213*  
*214*  
*215*  
*216*  
*217*  
*218*  
*219*  
*220*  
*221*  
*222*  
*223*  
*224*  
*225*  
*226*  
*227*  
*228*  
*229*  
*230*  
*231*  
*232*  
*233*  
*234*  
*235*  
*236*  
*237*  
*238*  
*239*  
*240*  
*241*  
*242*  
*243*  
*244*  
*245*  
*246*  
*247*  
*248*  
*249*  
*250*  
*251*  
*252*  
*253*  
*254*  
*255*  
*256*  
*257*  
*258*  
*259*  
*260*  
*261*  
*262*  
*263*  
*264*  
*265*  
*266*  
*267*  
*268*  
*269*  
*270*  
*271*  
*272*  
*273*  
*274*  
*275*  
*276*  
*277*  
*278*  
*279*  
*280*  
*281*  
*282*  
*283*  
*284*  
*285*  
*286*  
*287*  
*288*  
*289*  
*290*  
*291*  
*292*  
*293*  
*294*  
*295*  
*296*  
*297*  
*298*  
*299*  
*300*  
*301*  
*302*  
*303*  
*304*  
*305*  
*306*  
*307*  
*308*  
*309*  
*310*  
*311*  
*312*  
*313*  
*314*  
*315*  
*316*  
*317*  
*318*  
*319*  
*320*  
*321*  
*322*  
*323*  
*324*  
*325*  
*326*  
*327*  
*328*  
*329*  
*330*  
*331*  
*332*  
*333*  
*334*  
*335*  
*336*  
*337*  
*338*  
*339*  
*340*  
*341*  
*342*  
*343*  
*344*  
*345*  
*346*  
*347*  
*348*  
*349*  
*350*  
*351*  
*352*  
*353*  
*354*  
*355*  
*356*  
*357*  
*358*  
*359*  
*360*  
*361*  
*362*  
*363*  
*364*  
*365*  
*366*  
*367*  
*368*  
*369*  
*370*  
*371*  
*372*  
*373*  
*374*  
*375*  
*376*  
*377*  
*378*  
*379*  
*380*  
*381*  
*382*  
*383*  
*384*  
*385*  
*386*  
*387*  
*388*  
*389*  
*390*  
*391*  
*392*  
*393*  
*394*  
*395*  
*396*  
*397*  
*398*  
*399*  
*400*  
*401*  
*402*  
*403*  
*404*  
*405*  
*406*  
*407*  
*408*  
*409*  
*410*  
*411*  
*412*  
*413*  
*414*  
*415*  
*416*  
*417*  
*418*  
*419*  
*420*  
*421*  
*422*  
*423*  
*424*  
*425*  
*426*  
*427*  
*428*  
*429*  
*430*  
*431*  
*432*  
*433*  
*434*  
*435*  
*436*  
*437*  
*438*  
*439*  
*440*  
*441*  
*442*  
*443*  
*444*  
*445*  
*446*  
*447*  
*448*  
*449*  
*450*  
*451*  
*452*  
*453*  
*454*  
*455*  
*456*  
*457*  
*458*  
*459*  
*460*  
*461*  
*462*  
*463*  
*464*  
*465*  
*466*  
*467*  
*468*  
*469*  
*470*  
*471*  
*472*  
*473*  
*474*  
*475*  
*476*  
*477*  
*478*  
*479*  
*480*  
*481*  
*482*  
*483*  
*484*  
*485*  
*486*  
*487*  
*488*  
*489*  
*490*  
*491*  
*492*  
*493*  
*494*  
*495*  
*496*  
*497*  
*498*  
*499*  
*500*  
*501*  
*502*  
*503*  
*504*  
*505*  
*506*  
*507*  
*508*  
*509*  
*510*  
*511*  
*512*  
*513*  
*514*  
*515*  
*516*  
*517*  
*518*  
*519*  
*520*  
*521*  
*522*  
*523*  
*524*  
*525*  
*526*  
*527*  
*528*  
*529*  
*530*  
*531*  
*532*  
*533*  
*534*  
*535*  
*536*  
*537*  
*538*  
*539*  
*540*  
*541*  
*542*  
*543*  
*544*  
*545*  
*546*  
*547*  
*548*  
*549*  
*550*  
*551*  
*552*  
*553*  
*554*  
*555*  
*556*  
*557*  
*558*  
*559*  
*560*  
*561*  
*562*  
*563*  
*564*  
*565*  
*566*  
*567*  
*568*  
*569*  
*570*  
*571*  
*572*  
*573*  
*574*  
*575*  
*576*  
*577*  
*578*  
*579*  
*580*  
*581*  
*582*  
*583*  
*584*  
*585*  
*586*  
*587*  
*588*  
*589*  
*590*  
*591*  
*592*  
*593*  
*594*  
*595*  
*596*  
*597*  
*598*  
*599*  
*600*  
*601*  
*602*  
*603*  
*604*  
*605*  
*606*  
*607*  
*608*  
*609*  
*610*  
*611*  
*612*  
*613*  
*614*  
*615*  
*616*  
*617*  
*618*  
*619*  
*620*  
*621*  
*622*  
*623*  
*624*  
*625*  
*626*  
*627*  
*628*  
*629*  
*630*  
*631*  
*632*  
*633*  
*634*  
*635*  
*636*  
*637*  
*638*  
*639*  
*640*  
*641*  
*642*  
*643*  
*644*  
*645*  
*646*  
*647*  
*648*  
*649*  
*650*  
*651*  
*652*  
*653*  
*654*  
*655*  
*656*  
*657*  
*658*  
*659*  
*660*  
*661*  
*662*  
*663*  
*664*  
*665*  
*666*  
*667*  
*668*  
*669*  
*670*  
*671*  
*672*  
*673*  
*674*  
*675*  
*676*  
*677*  
*678*  
*679*  
*680*  
*681*  
*682*  
*683*  
*684*  
*685*  
*686*  
*687*  
*688*  
*689*  
*690*  
*691*  
*692*  
*693*  
*694*  
*695*  
*696*  
*697*  
*698*  
*699*  
*700*  
*701*  
*702*  
*703*  
*704*  
*705*  
*706*  
*707*  
*708*  
*709*  
*710*  
*711*  
*712*  
*713*  
*714*  
*715*  
*716*  
*717*  
*718*  
*719*  
*720*  
*721*  
*722*  
*723*  
*724*  
*725*  
*726*  
*727*  
*728*  
*729*  
*730*  
*731*  
*732*  
*733*  
*734*  
*735*  
*736*  
*737*  
*738*  
*739*  
*740*  
*741*  
*742*  
*743*  
*744*  
*745*  
*746*  
*747*  
*748*  
*749*  
*750*  
*751*  
*752*  
*753*  
*754*  
*755*  
*756*  
*757*  
*758*  
*759*  
*760*  
*761*  
*762*  
*763*  
*764*  
*765*  
*766*  
*767*  
*768*  
*769*  
*770*  
*771*  
*772*  
*773*  
*774*  
*775*  
*776*  
*777*  
*778*  
*779*  
*780*  
*781*  
*782*  
*783*  
*784*  
*785*  
*786*  
*787*  
*788*  
*789*  
*790*  
*791*  
*792*  
*793*  
*794*  
*795*  
*796*  
*797*  
*798*  
*799*  
*800*  
*801*  
*802*  
*803*  
*804*  
*805*  
*806*  
*807*  
*808*  
*809*  
*810*  
*811*  
*812*  
*813*  
*814*  
*815*  
*816*  
*817*  
*818*  
*819*  
*820*  
*821*  
*822*  
*823*  
*824*  
*825*  
*826*  
*827*  
*828*  
*829*  
*830*  
*831*  
*832*  
*833*  
*834*  
*835*  
*836*  
*837*  
*838*  
*839*  
*840*  
*841*  
*842*  
*843*  
*844*  
*845*  
*846*  
*847*  
*848*  
*849*  
*850*  
*851*  
*852*  
*853*  
*854*  
*855*  
*856*  
*857*  
*858*  
*859*  
*860*  
*861*  
*862*  
*863*  
*864*  
*865*  
*866*  
*867*  
*868*  
*869*  
*870*  
*871*  
*872*  
*873*  
*874*  
*875*  
*876*  
*877*  
*878*  
*879*  
*880*  
*881*  
*882*  
*883*  
*884*  
*885*  
*886*  
*887*  
*888*  
*889*  
*890*  
*891*  
*892*  
*893*  
*894*  
*895*  
*896*  
*897*  
*898*  
*899*  
*900*  
*901*  
*902*  
*903*  
*904*  
*905*  
*906*  
*907*  
*908*  
*909*  
*910*  
*911*  
*912*  
*913*  
*914*  
*915*  
*916*  
*917*  
*918*  
*919*  
*920*  
*921*  
*922*  
*923*  
*924*  
*925*  
*926*  
*927*  
*928*  
*929*  
*930*  
*931*  
*932*  
*933*  
*934*  
*935*  
*936*  
*937*  
*938*  
*939*  
*940*  
*941*  
*942*  
*943*  
*944*  
*945*  
*946*  
*947*  
*948*  
*949*  
*950*  
*951*  
*952*  
*953*  
*954*  
*955*  
*956*  
*957*  
*958*  
*959*  
*960*  
*961*  
*962*  
*963*  
*964*  
*965*  
*966*  
*967*  
*968*  
*969*  
*970*  
*971*  
*972*  
*973*  
*974*  
*975*  
*976*  
*977*  
*978*  
*979*  
*980*  
*981*  
*982*  
*983*  
*984*  
*985*  
*986*  
*987*  
*988*  
*989*  
*990*  
*991*  
*992*  
*993*  
*994*  
*995*  
*996*  
*997*  
*998*  
*999*  
*1000*

C6n1  
A13

the frame. A single frame occupation signal may be sent in each frame. It is important that its position within a frame be fixed and known to all nodes on the network.

*Paragraph beginning on page 12, line 9*

A14  
A

Note that it is not necessary to have one synchronization pulse per frame. Any suitable regular pattern can be used. The scheme described herein, however, is only an example intended to aid in illustrating the principles of the present invention.

*Paragraph beginning on page 13, line 30*

A15  
A

Once the link is successfully established (step 76), data frames can be transferred over the link between the source and destination nodes (step 78). The link is maintained by the periodic transmission of a frame occupation signal by both end nodes regardless of which node is transmitting or which is receiving (step 80).

*Paragraph beginning on page 14, line 1*

A16  
A

An example embodiment of the media capture method of the present invention will now be described. A flow diagram illustrating an example embodiment of the media capture method of the present invention is shown in Figure 4. First, it is assumed that node A wishes to initiate a data communication session with node B (step 90). Node A then waits for a free frame (step 91). Node A then determines, according to in accordance with a predetermined mechanism, in which of the upcoming free frames it is entitled to transmit (step 92). When the time for node A to transmit arrives, node A transmits in frame  $n$  a frame occupation signal and a technology dependent message to node B, e.g., a Request To Send (RTS) message (step 94). Note that a frame occupation signal transmitted during frame  $n$  refers to frame  $n+1$ .

*Paragraph beginning on page 14, line 26*

A17  
A

The synchronization method of the present invention will now be described in more detail. As described previously, the media access control mechanism of the present invention is operative applicable to networks using different technologies to coexist on the same shared media. The mechanism of capturing the media relies on the simultaneously placement of frame occupation signals at certain points in time by multiple nodes. The synchronization method described herein provides the necessary synchronization to the nodes attached to the media to enable the media capture method described hereinabove. Note that this mechanism is useful for the synchronization of any group of distributed nodes, especially when the nodes are implemented using different technologies.

*A 18*  
**Paragraph beginning on page 15, line 5**

Preferably, the control signals (or pulses), including the synchronization signal, the frame occupied signal, etc. comprise wide band signals with collision resistant signal characteristics. This means that if several nodes transmit the same signal at the same time, the simultaneous transmissions will not be canceled by each other and that any node that can hear at least one of the transmitting nodes will be able to detect the transmitted signal. Note that it is not necessary to be able to determine the source of any of the synchronization signals received by a node. It is important to note that the synchronization signal used be collision ~~resistance~~ resistant. Using a wide band signal is one way to achieve this.

*A 19*  
**Paragraph beginning on page 15, line 13**

Several types of wide band signals have the above described signal characteristics. ~~Two~~   
*A* ~~Three~~ examples include: (1) a sequence of several consecutive short single tone pulses, each pulse having a different frequency; (2) a wide-band bi-phase sequence with relatively good autocorrelation properties; and (3) several coherent single tone signals transmitted simultaneously.

*A 20*  
**Paragraph beginning on page 15, line 18**

A diagram illustrating the frame sequence when the synchronization signal comprises a plurality of tone signals each having a different frequency is shown in Figure 5. The sample frame stream, generally referenced 30, comprises a frame body 32, frame occupied signal 34 and synchronization signal 36 followed by a second frame body 40. The synchronization portion 36 is divided into ~~mini~~ sub slots of single tone pulses 38 labeled  $f_1, f_2, f_3 \dots f_p$ . Each node is adapted to transmit all frequency tones in the synchronization time slot in the same order.

*A 21*  
**Paragraph beginning on page 15, line 25**

All synchronization pulses transmitted by the nodes are identical and transmitted at the same time, ~~up to the~~ with a timing accuracy of limited to the synchronization process. Due to the spreading and ISI caused by a non ideal channel, however, they are received at any given node spread out over time in accordance with the following expression

*A 22*  
**Paragraph beginning on page 16, line 12**

A flow diagram illustrating the synchronization method of the present invention is shown in Figure 6. Each node is adapted to maintain its own internal free running clock. Upon wake-up, each node maintains its free running clock and derives which is used to derive frame timing from it (step 50). After wake-up, a node is operative to listen to the media for a predetermined length of time attempting and attempt to detect synchronization signals transmitted by other nodes (step 52).

*A* *23*  
*h* *24*

---

*Paragraph beginning on page 16, line 18*

If synchronization pulses are detected (step 54), the node derives a timing signal from the pulses (step 56) and aligns its internal clock in accordance with the timing signal, for example via a Phase Lock Loop (PLL) (step 58). After the node has aligned its internal clock with the received synchronization pulses, the node starts transmitting synchronization pulses randomly at the appropriate locations in time (step 60). ~~The pulses are transmitted randomly, meaning that at every frame, the node decides on a random basis whether or not to transmit the synchronization pulse in that particular frame. For example, a random number generator in a node adapted to provide a number between zero and one. A threshold is set to decide whether to transmit or not. For example, the threshold can be set to 50/50 meaning the synchronization signal will be transmitted with a 50% duty cycle. Note that duty cycles higher or lower can also be used depending on the particular application.~~ The synchronization pulses are transmitted randomly, meaning that the decision whether to transmit a synchronization pulse in that particular frame is determined randomly. A random number generator within the node is used to generate a random number between zero and one. A threshold number is chosen wherein if the random number generated is less than the threshold, the synchronization pulse is transmitted. If the random number generated is equal to or greater than the threshold, then the synchronization pulse is not transmitted. Thus, the threshold chosen corresponds to a duty cycle for transmission of the synchronization signal. To illustrate consider a threshold set to 0.25. This corresponds to a duty cycle of 25% meaning the synchronization signal will be transmitted in 25% of the frames. Note that the duty cycle chosen may be chosen depending on the particular application.

---

*h* *25*

---

*Paragraph beginning on page 18, line 4*

In some cases, a situation may arise whereby two or more groups of nodes share the same media but are located such that ~~due to media attenuation, they cannot hear each other due to media attenuation.~~ Thus, they operate independently from each other. As a consequence, the synchronization timing of the groups are likely to be out of ~~sync~~ synchronization with each other, since each operates asynchronously with respect to the others. Consider a node that is established in a position such that it can hear members of more than one group. This situation is illustrated in Figure 7 for the case of two disparate groups.

---

*A* *26*

---

*Paragraph beginning on page 18, line 15*

Since the synchronization of groups #1 and #2 are asynchronous with each other, node A will hear more than one synchronization signal. In accordance with the method of the present invention,

*Con 1*  
*ff 25*

node Z is operative to determine a combined average or converged synchronization timing that takes into account all the synchronization signals it receives. It then generates a synchronization signal skewed (or shifted) toward the converged timing that encompasses all the disparate groups it hears. A shifted synchronization signal is then output and heard by all the groups as shown in Figure 8. Gradually over time the synchronization timing of all the groups converge into a single to have the same timing.

*A 26*

Paragraph beginning on page 18, line 28

Referring to the example above, synchronization pulse 120 represents the pulse generated by group #1 and heard by node Z. Pulse 122 represents the pulse generated by group #2 and heard by node Z. Pulse 124 represents pulse 122 120 shifted towards the desired timing pulse 128 that combines the timing from groups #1 and #2. Likewise, pulse 126 represents pulse 122 shifted towards the desired timing pulse 128.